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SCOPE OF ETHANOL BLENDING WITH GASOLINE AND ITS IMPACT ON DIRECT AND INDIRECT EMPLOYMENT GENERATION IN RURAL AND URBAN INDIA

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The main objective of this study is to find the direct and indirect employment potential of introducing ethanol for blending with gasoline (petrol) at various blend levels. The present demand of ethanol mainly stems from the chemical and beverage industry and the growth in demand for these industries is projected till year 2011-12 on the basis of the past pattern and future opportunities. The demand projections for petrol are worked out using a detailed analysis from a study conducted by the National Council of Applied Economic Research (NCAER) in which consumption of petrol is taken as a function of private final consumption and real price. The molasses, secondary sugar juice and old cereals could be considered as the sources with potential at a reasonable economic cost. The use of these sources thus generates employment in the ethanol industry, sugar industry and agriculture sector for cereals and sugarcane production. The additional employment generation due to blending with petrol worked out in this study shows very high direct and indirect employment potential at 10 per cent or more level of ethanol blending with gasoline. Most of these sectors have rural linkages and hence the introduction of this programme would be a great boost to rural economic development and employment at 10 per cent or more level of ethanol blending with petrol.

I. INTRODUCTION

Ethanol, also known as ethyl alcohol or grain alcohol, is a clear and colourless liquid, made from starch-based crops or other cellulosic biomass materials. Ethanol can be produced from molasses that is a by-product of the sugar manufacturing process, from sugarcane juice itself, beet, potatoes, food-grains, and other trees and plants that contain starch, as well as from agricultural waste (bio-mass) and other cellulose bio-waste.

In India, ethanol is primarily produced from molasses so far, which is a by-product of sugar. The disposal of molasses is a problem, and hence arises the need to find a use for it. Before the alcohol-based chemical industry was developed, the demand for alcohol was limited, and therefore a large proportion of molasses was left unutilised. This was what prompted the government to explore ways by which ethanol produced from surplus molasses could be used. Several committees were formulated before implementing the decision that the alcohol-based chemicals industry should be encouraged.[1] We are faced with a similar problem once again. A study by Bedi and Gokaran (2002) for NCAER has found that the major source of ethanol production is molasses alone and it is in surplus to meet at least five percent additional blending demand with gasoline even after meeting the demand for beverage and chemical industry. Apart from being a substitute for fossil-based fuels, ethanol is also a clean-burning fuel, leading to reductions in carbon monoxide and carbon dioxide. Bedi, Gokaran and Pandey (2002) examined the issues related to ethanol availability, cost, technology, engine modification

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required in the vehicle and environmental impact and concluded that there is no harm in introducing ethanol blending with gasoline. India is among the nations that has decided to use ethanol blending with gasoline as an oxygenate for the above-mentioned reasons, and has already conducted field trials for this purpose. The government has decided to introduce 5 per cent blending with gasoline with effect from January 1, 2003.

This is indeed a positive development and five per cent blending was essential to utilise the excess molasses available. As the engines do not require any modification for less than 10 per cent blending, one could think of expanding the blending requirement in case ethanol could be made available from other resources at reasonable cost. Moreover, at the time of war or increase in petrol prices or scarcity of foreign exchange reserves, ethanol could be used as a substitute for petrol and blending could be a good beginning for that kind of situation. Moreover, additional ethanol demand could also be generated for the production of bio-diesel and at 20 per cent, no engine modification is required. Moreover, bio-diesel also offers high environmental benefits. However, a lot more work needs to be done to find out the potential wasteland and investment required to produce raw material for production of bio-diesels.

The demand and supply analysis of ethanol reveals that around 16 per cent equivalent ethanol required for ethanol blending with gasoline could be used to either for ethanol blending and/ or production of bio-diesel. This study, however, primarily focuses on the net impact of introducing ethanol blending on direct and indirect employment generation in the economy after reviewing the demand and supply availability for ethanol blending.

II. DEMAND FOR ETHANOL

1. Chemical and Beverage Industry

On the basis of Excise Commissioner data for the period 1995-96 to 1999-2000, provided by the Department of Chemicals and Petrochemicals (DCP), a three per cent growth in the chemical and beverage industry is expected for the next ten years. The slow growth in these industries is taking place due to stiff competition to alcohol based chemical industry from the petrochemical-based industry. The introduction of ethanol blending with gasoline is, in fact, going to further make things more difficult for the growth of these industries.

2. Demand Projections for Ethanol as a Motor Vehicle Fuel

The total demand of motor spirit during the year 2000-01 was 67 lakh metric tonnes, which is equivalent to 83,750 lakh litres. Since there is no change in mileage, replacing motor spirit entirely with ethanol would result in an equivalent demand of 83,750 lakh litres. In case of ethanol to be used as an oxygenate, the ethanol is used as some percentage of blend with gasoline.

The projections for demand for motor spirit is worked out by using the methodology adopted in the NCAER (2000) study. The demand for motor spirit depends upon its own price and the private final consumption expenditure. It has been assumed that private final consumption would grow at 5 per cent per annum and the real prices of motor spirit at 5 per cent. In the second method, the requirement of ethanol is based on the growth of motor vehicles. A very optimistic scenario for petrol demand is being ruled out as it is being replaced in several major cities with alternative fuels such as compressed natural gas (CNG).

Once the demand for chemical beverages and blending with gasoline is worked out by 2011-12, it could be aggregated to work out the total demand including for various blends. The total demand for ethanol including for 16 per cent blending is worked out in Table 4.

III. SUPPLY OF ETHANOL

The ethanol required for blending with gasoline could be produced from various alternatives depending upon the cost of production. Some of the ethanol blending requirement could be met from surplus molasses after meeting the beverage and chemical industry demand. The second major source of ethanol blending is secondary sugar juice and its by-product, molasses. Both these sources, viz. molasses and sugar juice (including its by product molasses) would grow on the basis of growth in sugarcane production and its usage.

1. Estimates of Sugar Production by Year 2011-12

From the pattern of sugarcane growth observed for the last three decades, a growth of 2.7 per cent per annum in sugarcane production could be taken as the expected growth rate for the period 1999-2000 to 2011-12. The sugarcane is used to produce white sugar, seed and feed and *gur* and *khandsari* sector production. Based on the growth rate of varied usage observed in the past, the future growth and level of sugar usage could be worked out. However, these values are adjusted proportionately to balance the production of 2.7 per cent per annum, as estimated in Table 1.

Table 1
Forecast for Potential Sugarcane Usage: Based on Assumption of 2.7 Per Cent Per Annum Growth in Production

		Usage in (lakh tons)			*% share of various sugar cane usage in*		
Period	*Production sugarcane (lakh tons)*	*White sugar*	*Seed*	*Gur & khandsari*	*White sugar*	*Seed*	*Gur & khandsari*
1976-77	1530	490	183	857	32.0	12.0	56.0
1980-81	1542	516	182	844	33.5	11.8	54.7
1990-91	2410	1223	286	902	50.7	11.8	37.4
1995-96	2811	1742	330	739	62.0	11.7	26.3
1999-00	2992	1785	356	851	59.7	11.9	28.4
2000-01	3065	1860	355	849	60.7	11.6	27.7
2001-02	3140	1939	355	846	61.7	11.3	27.0
2002-03	3219	2021	354	844	62.8	11.0	26.2
2003-04	3301	2106	353	842	63.8	10.7	25.5
2004-05	3387	2195	352	840	64.8	10.4	24.8
2005-06	3477	2288	352	837	65.8	10.1	24.1
2006-07	3570	2384	351	835	66.8	9.8	23.4
2007-08	3668	2485	350	833	67.7	9.6	22.7
2008-09	3770	2590	350	831	68.7	9.3	22.0
2009-10	3876	2699	349	828	69.6	9.0	21.4
2010-11	3987	2813	348	826	70.5	8.7	20.7
2011-12	4103	2932	347	824	71.5	8.5	20.1
% p.a. Gr Rt. During 1999-00 to 2011-12	2.7	4.2	-0.2	-0.3			

Source: Derived by using DES data.

Thus, the major change in pattern of sugarcane consumption is taking place and it is expected to continue in future as well. The white sugar production is expected to grow by 4.2 per cent per annum (Table 2). The share of seed and feed stock consumption is expected to decline marginally. On the other hand, the *gur* and *khandsari* share is expected to decline significantly mainly due to decline in the *khandsari* sector. The *gur* is produced and consumed traditionally in rural areas and a decline in its quantum over time may not take place substantially especially for self-consumption. However, its market sale may decline.

Table 2
Sugarcane Production and Consumption Growth Pattern

(Per cent)

Period	*Production*	*Usage in*		*Gur &*
	Sugarcane	*White sugar*	*seed*	*khandsari*
71-72 to 80-81	2.7	5.9	1.2	0.2
81-82 to 90-91	4.8	11.7	4.8	1.0
91-92 to 99-00	2.7	6.6	2.7	1.4
71-72 to 99-00	3.4	6.9	2.7	0.8
1999-00 to 2011-12 (forecast)	2.7	4.2	-0.2	-0.3

The production of molasses is assumed to be equivalent to 40 per cent of sugar production by weight. The conversion factor for ethanol from molasses is one ton of molasses for 225 litres of ethanol. However, only 90 per cent of molasses volume is available for distillation after meeting the other requirements. Thus increasing the volume of sugar production would lead to a rise in molasses production, which would mean that ethanol production potential from molasses would also increase by 4.2 per cent per annum.

But there is a need for caution. The extra production over demand is not sustainable in the medium or long run unless alternative demand is worked out. Thus this extra production is not sustainable and has been taken out from the potential mentioned through molasses route especially for future scenario.

This is the cheapest mode of ethanol production except damaged cereals (potential from damaged cereals is low) and the cost of production is Rs. 11.33 per litre. The molasses cost taken is Rs. 1,500 (Rs. 1000 prices + Rs. 500 per tonne excise). Thus the price is comparable during 2001-2002 with import parity price of Rs. 11.50 (on the basis of $ 25 per barrel import price of petrol).

2. Ethanol Potential from Sugar Juice and its By-products, Molasses by 2001-02

This could be produced from the following two sources.

(i) Excess Sugar Production

The analysis of production and consumption data of sugar during last several decades shows that production and availability of sugar is in excess of domestic consumption. This production of sugar and hence the molasses available from it is not sustainable unless alternative usage is found out. The same logic could be applied to the sugar cane used for this excess sugar production. Thus unless alternative demand of ethanol in the form say ethanol blending is not generated, the entire value added and employment chain from surplus sugar cane, sugar, and ethanol would be diminished. We need to work out this estimate of surplus sugar availability.

Based on data of last eleven years during the 1990s on an average, 4.7 per cent sugar produced is in excess of domestic consumption and exports (Table 3). The export of sugar on an average worked out is 3.7 per cent of the production during the 1990s.

Table 3
Average Production, Consumption and Availability of Sugar

(lakh tons)

Period	*Production*	*Dom. Cons*	*Avaliability*	*Dom. Con/Pro %*	*Imports*	*Exports*	*(Prof+Imp) (Dom Con+Exp) /Prod*	*Availability /(Dom (Con+Exp) %*
1960-61 to 69-70	29.5	25.5	36.3	86.5	0.0	2.7	104.6	128.7
1970-71 to 79-80	44.0	41.7	58.8	94.8	0.2	4.7	95.3	126.7
1980-81 to 89-90	78.3	79.4	104.2	101.4	4.4	1.7	102.0	128.5
1990-91 to 2000-01	140.9	133.2	197.1	94.5	2.5	3.7	104.7	144.0
2000-01	185.1	160.8	285.2	86.9	0.0	12.8	122.8	177.4

Source: Data from ISMA.

This excess production is used to pile up the stocks. The excess supply of sugar is evident from the need of a quota on the release of sugar to control prices. The excess supply of sugar could be maintained at 4.2 per cent per annum growth in sugar production as similar growth rate is observed in consumption pattern of sugar in the past. Excess Sugar could therefore be utilised to produce sugar juice and then to produce ethanol.

(ii) Khandsari Juice or Sugar Juice

The additional amount of khandsari juice could be produced by allowing additional processing from khandsari to ethanol. The other alternative is to shift *khandsari* production for sugar juice production and then ethanol.[2] A similar pattern is not suggested for the *gur* industry as *gur* is rich food as compared to sugar and has lots of nutritious value. *Gur* is also used to produce desi alcohol. Thus *khandsari*, which is neither rich food nor has traditional values, could be used for the purpose. This has been assumed considering the fact that *khandsari* is mainly produced in India to consume the surplus sugarcane. Thus *khandsari* growth is supply driven. The fluctuations in crop could be taken care of by monitoring the percentage of blending during the year of a bad crop.

NCAER (1997) analysis worked out that sugarcane use in the *khandsari* and *gur* sector is in the ratio of 1 to 3 during 1994–95. Using this data in Table 1, it is worked out that around 212 lakh tons of sugarcane is used to produce *khandsari* and 637 lakh tons to produce *gur* during 2001–2002. The growth in *gur* production is taken at 0.8 per cent per annum during 2001–2002 to 2011–12. This leaves around 134 lakh tons of sugarcane to be consumed in the the khandsari sector during 2011–12, which account for 4.6 per cent of the sugarcane consumption in the sugar industry during 2011–12.

Thus, approximately 4.6 per cent of sugarcane as percentage of usage in sugar industry could be considered for ethanol production from the *khandsari* sector till year 2011-12. However, one should take care that the maximum limit to produce ethanol by using this route is restricted to 8218 lakh tons as there is some difference in sugarcane conversion to sugar and *khandsari* sector.[3]

Based on the above two arguments, and on the basis of assumption that around one percentage point less from each source could safely be used to produce ethanol. Thus, approximately 7.3 per cent[4] of sugarcane used for sugar production could be used for sugar juice to finally produce ethanol. The 7.3 per cent of sugarcane could produce 10201[5] lakh litres of alcohol during 2000-01 from 185.1 lakh tons of sugar. In addition, excess sugar production also produces molasses, which could be used to produce 686[6] lakh litres of alcohol. However, care has to be taken to exclude molasses available from 3.7 per cent of excess sugar produced from molasses route. So that it is not being double counted.

Thus, 10887 lakh litre of alcohol could be produced from sugar juice and its by products during 2000-01. Using this kind of analysis for each year, the total availability of alcohol worked out from sugar juice and molasses route during 2001-02 is estimated at 11350 lakh litres and by year 2011-12 at 17127 lakh litres.

The cost of production of ethanol is Rs 14.73 per litre from sugar juice and its molasses during 2001-02. Thus there is need of subsidy of Rs 3.23 per litre during 2001-02 for blending by adopting this route. However we cannot charge different price from various user in a market mechanism. Thus, the ethanol to chemical and beverage industry should also be made available at Rs 11.50 during 2000-01 in addition to quantum required for blending. Similarly the pricing of ethanol is problem as the marginal cost is different from various sources. For a market mechanism to work, the price should be fixed at the high marginal cost, unless it is administrated through fiscal or other controls. However, fixing different prices for ethanol production from various sources such as molasses and sugar juice is not possible without elaborate administrative controls.

The alternative is to use a certain percentage of secondary use for ethanol production; the cost of production is even lower than the cost of ethanol production from molasses. This would however mean higher cost for sugar produced from primary juice, but quality of sugar would definitely be better.

3. Ethanol from Old Cereals

Based on the additional surplus available over time, the potential for ethanol production is estimated using Indian Agricultural Research Institute (IARI) assumption of 400 litres/ton of biomass. The ethanol availability on the basis of average of last ten years surplus cereals available over and above the minimum stock even after allowing for yearly depletion is estimated at 16412 lakh litres.

The average for the last ten years should take care of fluctuation in the agriculture crop. To be more cautious, one could further argue that even this entire average surplus amount over and above the minimum required should not be allotted for using ethanol production. However, there is an argument in favour of using old cereals for ethanol production. Keeping the cereals for long and that too not in a very appropriate conditions puts lots of unnecessary storage cost, when storage is not required over and above the minimum surplus required for food security. Moreover, over-storage destroys the nutritious value of food. Thus, this supports the case for putting an argument for use of surplus cereals over and above the minimum required. However, as discussed it is costly to produce ethanol from cereals. Here the economical way out to cut storage cost and also have relative fresh cereals in storage is to allow the use of oldest stocks from storage capacity at relatively lower rate than fresh food, but at much higher rate than damaged food grain. The formula to allow the use of cereals from stock should depend upon

the weighted production during last five years. The relatively high weights should be given to latest years production to maintain the stock security, but the disposal of oldest stock should be given priority. At any point of time the stocks below than minimum surplus level for food security should not be allowed to deplete. One could also think of giving weights to stocks over and above the minimum required level for food security.

For our present exercise, the weighted average production of cereals for five-year could be safely assumed at 185 million tons. On the basis that 0.5 per cent of it could be used for ethanol production provided minimum stock is maintained. Thus it means 0.925 million tons (9.25 lakh tons) of cereals, which could produce 3700 lakh tons of ethanol. The future growth in it could be taken as 1.25 per cent per annum on the basis of growth in production. From the point of subsides to be nil, the cost of production of ethanol should match the import parity price of oil. The cost of production of ethanol from cereals is Rs 19.57 per litre and raw material cost in it is Rs 15.38 (taking Rs 6200 per tonne food grain).

To make the subsidies nil for ethanol production from cereals at import parity price of Rs 11.50 during 201-02, the old food stock of 9.25 lakh tons needs to be made available at Rs 3,950 per ton instead of Rs 6,200 for fresh food grains (taken the example of wheat). This means a price of 64 per cent of the fresh value, i.e. at a rate 36 per cent at lower rate than minimum support price. This includes 2 lakh tons of stock provided by Food Corporation of India (FCI) at Rs 745 per tons. Thus there is question of pricing of remaining 7.25 lakh tons food stock, which needs to be sold in the range of Rs 4834 per tons. This means 22 per cent at lower price for 7.25 lakh litres stock during 2001-02 than the minimum support price during base year[7], which is further going to reduce based on 1 per cent real depreciation in rupee. This comes to around Rs. 99 crore subsidies during base year. Naturally, this much lower price is justifiable both from the point of view of poor quality of food grain due to storage over time and the cost to nation in return for need to have food security. One could work out the mechanism to recover this money from consumer in return for price stability. Otherwise also as far as FCI is concerned, the Public Distribution System (PDS) price is not any way higher than this price. The releasing of old stocks and better monitoring could any way lower the wastage.

4. Alcohol Potential from Straw

Experiments are going on to produce ethanol from straw. However, the rice straw has a theoretical potential to produce straw as per data provided by IARI. But the straw is being used as feedstock in most of states except Punjab and Haryana. Punjab and Haryana provide better feedstock to animals and instead burn straw amounting to 50 lakh tons. One ton of straw has a potential to produce 250 litres of alcohol. Thus the total alcohol potential from straw in these two states is estimated at 12,500 lakh litres. However, this potential has a very high conversion cost and the transport cost of straw is also high. Thus it is not economical to produce ethanol from straw.

5. Ethanol Potential from Molasses, Sugar Juice and Old Cereals

Thus molasses, secondary sugar juice and old cereal stocks could be considered as the potential sources of ethanol production on the basis of cost of production and existing technology. The supply estimated from various sources during the period 2000-01 to 2011-12 is then compared with the realistic demand from chemical and beverage industry and quantum required for blending with gasoline in the following section.

There is possibility that ethanol production from secondary juice may not materialise to that extent due to decline in sugarcane production. This is because sugar is produced far in excess due to various subsidies mainly water and state incentives. There are various studies going and as per the available information NPC, EPC and EPS are higher than one for sugarcane in India. Thus, the withdrawal of these subsidies could lead to decline in sugarcane production, but the production of other crops are expected to increase. This is another question that the extra production of cereals would either lead to increase in its stocks as all of it cannot be exported or could be used in the ethanol production process. This is even worse than producing extra sugar cane. Considering the percentage of areas with water shortage areas growing sugarcane, the sugar cane production may decline by 4 per cent, which is sufficient to meet 10 per cent blending requirements rather than 16 per cent without decline. However, there are other options as 25 to 35 per cent of additional sugarcane is used to produce khandsari and gur for final use, which is not considered in above analysis. A portion of this gur and khandsari products could be used to produce ethanol. However, here is a note of caution as any subsidies for ethanol blending or a high demand for sugar could actually kill the gur industry and has the potential of diverting sugarcane from gur to sugar sector to finally produce ethanol for blending. The total employment generation in the gur sector is estimated around 3.5 lakh and most of it is rural-based. Its replacement may take place in the sugar industry with 1.25 lakh persons. However, the share of gur industry is reducing and ethanol blending may just speed up the process. However, the immediate decline could be avoided by taking care and not providing subsidies as declared by the government for ethanol blending with petrol. It is also important not to provide subsidies for the survival of the chemical industry. Thus there is need for proper planning for expanding the scope of ethanol blending with gasoline from 5 to 10 per cent and then to 15-16 per cent.

There is another option. Ethanol could also be used in the production of bio-diesel and 20 per cent blending in it do not require engine modification. As diesel demand is around 4.5 times that of petrol and it is expected to decline to 3 times by year 2001-12. The ethanol required to produce bio-diesel is 13.4 per cent of bio-diesel demand. Thus for 10 per cent of bio-diesel production, ethanol requirement is estimated to be 5 per cent equivalent of ethanol blending with gasoline. Bio-diesel has more environmental benefits compared to ethanol blending and has vast potential for rural employment generation in wasteland. However, a lot more work is required to find out the potential wasteland and investment required to produce raw material for production of bio-diesels. But of course 5 percent or more ethanol worked for blending in this article could be meant for bio-diesel.

IV. DEMAND, SUPPLY AND SUBSIDIES

The total demand of ethanol in chemical, beverage and other usage as well as for blending is worked out in Table 4. The supply of ethanol from various resources is also given in Table 5.

The demand for ethanol including for 16 per cent blending could be meet using molasses, secondary sugar juice and old cereals route. The data in Table 4 indicate that ethanol demand including for 5 per cent blending could be met from the molasses route alone. The secondary sugar juice route needs to be exploited in addition to the molasses route to meet the demand including for 10 per cent blending with gasoline. In case old cereals stocks potential are added to molasses and sugar juice route, we could meet the demand

Table 4
Total Demand for and Supply of Ethanol *(lakh litres)*

Year	*Ethanol demand for*			*Ethanol supply from*			
	Chemical beverages & others	*16% blending*	*Total including blending*	*Molasses*	*Secondary sugar juice*	*Old cereals*	*Total*
2001-02	10265	14416	24681	15115	11350	3700	30165
2002-03	10573	15504	26077	15737	11827	3746	31310
2003-04	10890	16678	27568	16440	12323	3793	32556
2004-05	11217	17939	29156	17142	12841	3840	33823
2005-06	11553	19296	30849	17842	13380	3888	35110
2006-07	11900	20755	32655	18542	13942	3937	36421
2007-08	12258	22326	34584	19401	14528	3986	37915
2008-09	12625	24013	36638	20179	15138	4036	39353
2009-10	13003	25830	38833	21037	15774	4087	40898
2010-11	13393	27786	41179	21892	16436	4138	42466
2011-12	13796	29885	43681	22829	16664	4189	43682
% p.a Gr. Rt during 2000-01 to 2011-12	3.0	7.6	5.9	4.2	3.9	1.3	3.8

requirements including for 16 per cent blending. Thus in most of analysis that follows an assessment is made for employment and subsidies potential for 16 per cent blending.

V. EMPLOYMENT POTENTIAL DUE TO INTRODUCTION OF BLENDING WITH GASOLINE

The additional employment generation is estimated due to introduction of 16 per cent blending with gasoline. Here there is need to look at several aspects. Firstly the ethanol is substituted with value addition in petrol and refinery industry, which has very low employment intensity and is mainly supported by imports. Secondly, does the blending of ethanol with gasoline cause displacement in employment at raw material stage due to its scarcity or is it being generated with the help of additional resources? In this study growth of ethanol blending is considered by producing extra ethanol production and growth rate for chemical and beverage industry is taken on the basis of past pattern. Thus blending of ethanol with gasoline is not displacing employment in any other industry (except a very small percentage in petroleum and refinery) and in fact generates net direct and indirect employment in ethanol, sugar, sugarcane and cereal production. This is based on the assumption that surplus sugar and cereal production is not sustainable in the long run unless additional demand is generated and hence employment in that part is based on additional demand in the form of ethanol blending. This is relevant, as the excess cereal cannot be stored unless alternative usage is made such as ethanol blending. Otherwise production and employment has to be curtailed to that extent as it not sustainable. The introduction of ethanol blending with gasoline has created additional employment generation in agriculture sector without even considering shift in crop pattern. This is because the sustainability of growth on the basis of past pattern was not possible without finding its additional usage.

To work out the impact of introducing ethanol blending with gasoline, it is important to know the alternative resources from which ethanol demand for various purposes is met (Table 5).

Table 5
Ethanol Supply to Meet Demand Including for 16 Per Cent Blending from Various Sources
(lakh litres)

Period	*Demand in chemical, beverages and other usage*	*Ethanol prod. from excess available*		*From khandsari juice or sugar juice*	*old cereals*	*Total*
		Molasses	*Sugar juice & its by product*			
1	*2*	*3*	*4*	*5*	*6*	*7*
2001-02	10265	4850	5597	3969	0	24681
2002-03	10573	5164	5832	4508	0	26077
2003-04	10890	5550	6077	5050	0	27568
2004-05	11217	5925	6333	5681	0	29156
2005-06	11553	6289	6599	6408	0	30849
2006-07	11900	6642	6876	6690	547	32655
2007-08	12258	7143	7164	6970	1049	34584
2008-09	12625	7554	7465	7263	1731	36638
2009-10	13003	8034	7779	7569	2448	38833
2010-11	13393	8499	8106	7887	3294	41179
2011-12	13796	9033	8446	8218	4188	43681
% p.a Gr Rt during 2000-01 to 2011-12	3.0	6.4	4.2	7.5	–	5.9

The second column is related to demand in the chemical and beverage industry and is hence not relevant for the purpose of additional employment generation due to ethanol blending with gasoline. The third and fourth columns reveal details about ethanol production from excess available molasses and sugar respectively. The fifth column is related to ethanol production from *khandsari* or sugar juice. The sixth column relates to the ethanol production from old cereals. Thus, the third, fourth, fifth and sixth columns are relevant for the additional employment generation in the ethanol industry.

1. Direct Employment Generation in the Ethanol Industry

Bedi and Gokaran (2002) study sponsored by MFPI worked out employment, value added and investment during the Ninth Plan and made projections for the Tenth Plan for various food processing industries at NIC four digit level in both the organised and unorganised sectors. This study shows that 21,354 persons were employed in the ethanol industry (NIC code 220) during 1997-98 to produce 8,305 lakh litres of alcohol. Thus direct employment generation in the ethanol industry per lakh litre of alcohol is estimated to be 2.57 persons. Applying this number in Table 5, the direct employment generation due to 16 per cent of ethanol blending with gasoline could be worked out. Thus 76,804 persons are employed directly in the ethanol industry due to 16 per cent blending requirement. However, this would also replace the employment in the petrol segment to the extent of decline in petrol demand. The total employment generation in petrol industry per lakh litre of petrol worked out is 0.05 persons.[8] Thus the net addition in direct employment is estimated to be 75,310 during 2011-12 due to the introduction of ethanol blending with gasoline in the economy.

The next step is to assess the additional employment generation in the sugar and khandsari sectors due to additional blending demand.

2. Employment Generation in the Sugar and Khandsari Industry due to 16 Per Cent Blending with Gasoline

The Bedi and Gokaran (2002) estimated the number of employees for NIC code 207 at 6,99,179 during the year 2001-02. Using the quantum of sugarcane consumed in the sugar, *khandsari* and gur sectors and the employees working for industry NIC code 207 (i.e. gur, *khandsari* and sugar sector), the number of employees per lakh tons of sugarcane consumption is estimated to be 251.05. From the Annual Survey of Industries (ASI) unit-wise data at four-digit level, it is worked out that employees per unit of input in sugar, *khandsari* and gur industry are in the 1: 2: 3.3 ratio. Thus distribution of work force is applied on the total employment in NIC 207 industry to work out the employment in sugar, khandsari and gur industry. The results derived are given in Table 6.

Table 6
Forecast for Potential Sugarcane Usage and Employment

	Sugarcane usage in (lakh tons)			*Persons Employed in (No.)*			
Period	*White sugar*	*Gur*	*Khandsari*	*White sugar*	*Gur*	*Khandsari*	*Total*
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1999-00	1785	637	214	280065	329363	67153	676581
2000-01	1860	637	212	291832	329363	66525	687721
2001-02	1939	637	209	304227	329363	65584	699174
2002-03	2021	642	202	317093	331998	63357	712448
2003-04	2106	647	195	330429	334654	61118	726201
2004-05	2195	652	188	344393	337331	58865	740590
2005-06	2288	658	179	358985	340030	56286	755301
2006-07	2384	663	172	374047	342750	54007	770805
2007-08	2485	668	165	389894	345492	51716	787102
2008-09	2590	674	157	406368	348256	49411	804035
2009-10	2699	679	149	423470	351042	46779	821291
2010-11	2813	684	142	441357	353850	44447	839654
2011-12	2932	690	134	460028	356681	42101	858810
% p.a. Gr Rt. During 1999-00 to 2011-12	4.2	0.7	-3.8	4.2	0.7	-3.8	2.0

Note: Gur and Khandsari sector sugarcane consumption is worked out assuming constant production in gur sector.
Source: Derived by using DES data.

The entire employment in sugar industry worked out in Table 6 is segregated to find out the impact of introducing ethanol blending using data from Table 5 on the basis of agriculture raw material consumed. The basic agriculture raw material required in producing the ethanol as product or by-product is given in Appendix 1 and is worked out on the basis of details explained in methodology explained above.

The relevant columns for additional employment generation in sugar and even for the agriculture sector are represented in columns 4 and 6 of Table 5. The purpose is to find the employment generation in sugar industry in utilising the surplus sugar, as surplus production is not sustainable without finding additional demand. The fifth column of Table 5 is not taken

into account for employment generation in the *khandsari* sector or even for sugarcane used to that extent as *khandsari* was produced even earlier and was sustainable even without generating additional demand for blending. The employment generation worked out to produce sugar from cereals is worked out on the basis of quantum of ethanol produced from Table 5 using ratios similar to sugar production from sugarcane in the absence of relevant data. The results arrived at are summed up in Table 8.

3. Employment Generation in the Agriculture Sector

Both columns 4 and 6 of Table 5 could be treated as factors responsible to sustain the employment generation even in agriculture sector by introducing ethanol-blending programme.

Using data from Indian Agriculture Research Institute (IARI) regarding man-hours required to produce various crops per hectare of land and yield of various crops, the man-hours requirement per ton of various crops is worked out in Table 7.

Table 7
Labour Used to Produce Different Crops per Hectare of Land

Items	*Rice*	*Wheat*	*Jowar*	*Bajra*	*Maize*	*Potato*	*Cassava*	*Sugarcane*
Human labour (Man Hrs.)	1124	325	481	368	626	1803	1065	1445
Yield (t/ha)	1985	2583	826	635	1655	18643	24000	70825
Persons /lakh ton	35.4	7.9	36.4	36.2	23.6	6.0	2.8	1.3

Note: Persons worked on the basis of 8 hours per day and 200 working days per annum.
Source: Derived by using data from IARI.

This could be used to work out the additional employment generation in the agriculture sector by applying it on the quantum of agriculture raw material required in introducing ethanol bending. The results thus arrived at are summed up in Table 7. The employment generation in the agriculture sector is taking place in rural areas.

4. Total Direct and Indirect Employment Generation

The whole impact on direct and indirect employment generation due to introduction of ethanol blending is worked out in Table 8. The additional direct and indirect employment thus worked out is 1.5 lakh during 2001-02 which would increase to 4.5 lakh by the year 2011-12. This is against the total employment of 29.8 lakh during 2001-02 and 47.7 lakh by year 2011-12. This employment of 47.7 lakh covers the entire ethanol industry and its backward linkages in the sugar, khandsari and agriculture sectors. Thus the ethanol industry has large direct and indirect employment linkages.

The impact of 5 per cent blending is much lower on the additional employment generation as most of it could be produced from available molasses sources, which is already being produced to meet the exiting sugar demand. Hence additional employment generation in agriculture and sugar sector is negligible. This backward linkage improves at higher level of blending. Thus the introduction of this programme would be a great boost to rural economic development at 10 per cent or more level of blending. The additional direct and indirect employment generation due to introduction of 5 per cent blending is only 24,213 and at 10 per cent blending is 2,21,853 during 2011-12, the detail of which is given in Appendix 2. The additional employment generation due to introduction of 16 per cent blending is 4.48

Table 8
Total Direct and Indirect Employment Potential for 16 Per Cent Blending *(No.)*

Period	*Ethanol industry*		*Sugar & Khandsari industry*		*Agriculture sector*			
	Total	*Addl.*	*Total*	*Addl.*	*Total*	*Addl.*	*Total*	*Additional*
(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8) = (2) + (4) + (6)*	*(9) = (3) + (5) + (7)*
2001-02	63430	36328	321807	12395	2593500	102700	2978737	151423
2002-03	67018	39070	337082	12930	2709200	106600	3113300	158600
2003-04	70850	42026	352767	13440	2830100	111800	3253717	167266
2004-05	74931	45206	369509	13999	2957500	115700	3401940	174905
2005-06	79282	48626	387356	14608	3091400	120900	3558038	184134
2006-07	83923	52303	403959	15476	3248546	151946	3736428	219725
2007-08	88881	56262	421135	16254	3407465	180865	3917481	253381
2008-09	94160	60513	439239	17224	3581390	218290	4114789	296027
2009-10	99801	65092	457958	18189	3763468	258668	4321227	341949
2010-11	105830	70021	477633	19268	3958142	305142	4541605	394431
2011-12	112260	75310	498118	20375	4160283	352583	4770661	448268
% p.a. Gr Rt during 2000-01 to 2011-12	5.9	7.6	4.5	7.56256	4.8	13.1	4.8	11.5

lakh (Table 8). The employment linkages with ethanol industry could be further improved by adopting different crop pattern, which saves scarce resources and optimises the employment generation. One of the instruments to achieve these objectives is price policy.

5. Share of Rural Employment in the Ethanol, Sugar, *Gur*, *Khandsari* and Sugar Industries

These employment linkages could be traced to rural and urban sector break-ups using Economic Census and ASI data. The analysis for NIC Codes 207 and 220 industry at four digit NIC classification level clearly brings out the rural based dominance of all industries in this group. The direct employment generation in alcohol-based industry is pre-dominantly rural based (57 per cent). The indirect employment generation is more important as the entire employment generation for inputs required in agriculture sector are rural based. The rural share of employment for sugar industry is 51 per cent, khandsari, 82 per cent and gur, 98 per cent. Thus the development of this industry could provide a real impetus to the development of the rural-based industry. However a care is needed that the selection of states has to be pursued on the basis of the available resources in various states. Uttar Pradesh, Maharashtra, Tamil Nadu and Karnatka, Andhra Pradesh and Gujarat are the states that could be selected for higher blending based on molasses and sugar juice source. Punjab, Andhra Pradesh, Maharashtra, Haryana and Madhya Pradesh could be selected for ethanol production from cereals.

VI. CONCLUSIONS

The major benefit of introducing ethanol blending with gasoline is in terms of employment. The impact of 5 per cent blending is much lower on the additional employment generation as most of it could be produced from the available molasses sources, which is already being

Table 9
Share of Rural Employment in the Ethanol, Sugar, Gur & Khandsari Industries during 1997-98

Industry description	*NIC code*	*Total no. of employees*	*Small sector share*	*Rural share*
Distilling, rectifying and blending of spirits; ethyl alcohol production from fermented materials	2200	16658	61.3	57.2
Manufacture of '*gur*' from sugar cane	2071	367859	99.3	97.6
Manufacture of '*khandsari*' sugar from sugarcane	2073	96993	63.6	81.6
Manufacture of other indigenous sugar-cane /sugarbeet/palm juice products n.e.c.	2079	3052	96.4	50.9

Source: Derived by using data from Annual Survey of Industries and Economic Census.

produced to meet the existing sugar demand. Hence, additional employment generation in the agriculture and sugar sectors is negligible for 5 per cent blending, though it is quite high for 10 per cent and 16 per cent blending. Thus, backward linkage improves at a higher level of blending. Thus the introduction of this programme would be a great boost to rural economic development and employment at 10 per cent or more level of ethanol blending with petrol.

However, there is need for caution as mentioned above since any subsidies for ethanol blending or a high demand for sugar could actually kill the *gur* industry and divert from gur to sugar sector to be finally used in ethanol production. But as the gur industry is anyway diminishing, the introduction of ethanol blending with petrol cannot be held accountable for it. But it could definitely speed up the process. It is therefore important to be careful and to avoid providing subsidies. However, the government has already declared excise incentives worth Rs 0.70 per litre of ethanol blending, which would make things difficult for the chemical industry. Thus there is need for proper planning for expanding the scope of ethanol blending with gasoline from 5 to 10 per cent and then to 15-16 per cent. The implications of this need to be carefully studied at each stage to prevent adverse results. The survival of the gur and khandsari industry may become difficult in case the mandatory requirement for blending is increased without proper planning as all the sugarcane in that case may end up being used for sugar and then ethanol production. It is also suggested that we may have to opt for a combination of ethanol blend and bio-diesel rather than merely go on increasing ethanol blending with gasoline. Bio-diesel has more environmental benefits as compared to ethanol blending and has vast potential for rural employment generation in wastelands. However, a lot more work is required to find out the potential wasteland and investment required to produce raw material for production of bio-diesels.

Notes

1. Presently, the alcohol-based chemicals industry forms an important segment of the chemical industry in India. The annual turnover is around Rs. 3,000 crores, and the industry provides direct employment to about 6,000 to 8,000 persons, and further indirect employment to about 4,000 to 5,000 persons. India is a world leader in this sector, with the chemicals industries in most other countries relying on petro-chemicals for their base.
2. This, however, would require additional resources to install additional sugar mills. Moreover, the fluctuation in sugarcane production could be better tackled by not allowing khandsari production during the time of sugarcane shortage. This is a very efficient way to tackle fluctuations with a small amount of investment. However, the disadvantage is that the recovery of khandsari from sugarcane is 7.5 as compared to 9.2 for sugar.
3. 134*750*7.5/9. This is based on the assumption that recovery of khandsari from sugarcane is 7.5 as compared to 9.2 in case of sugar.

4. (4.7-1) % + (4.6-1) % = 9.3 %)
5. 185.1*.073*750
6. ((185.1*0.40)*225)*.037
7. By year 2011-12, the price difference would be further reduced on the basis of assumption of 1 per cent real depreciation in the rupee exchange rate.
8. One litre of alcohol fuel gives mileage per vehicle approximately equivalent to one litre of petrol. The total production of petrol presently is 78,980 lakh litres and of diesel 3,93,300 lakh litres and industry employees 24612 persons.
9. The recovery of *khandsari* from sugarcane is 7.5 as compared to 9.2. One ton of sugar could produce 750 litre of alcohol. The production of molasses is assumed to be equivalent to 40 per cent of sugar production by weight. The conversion factor for ethanol from molasses is one ton of molasses for 225 litres of ethanol. However, only 90 per cent of molasses volume is available for distillation after meeting the other requirements. For cereals, the potential for ethanol production is based on 400 litres/ton of biomass and on the assumption that employment per tone sugar from cereals is same as from sugarcane.

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